In search of the 'Holy Grail'

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University-Industry Relationships at the University of Groningen

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Preface

Publication of this research is one of the follow-up activities of the 25th anniversary of the science shops of the University of Groningen (RUG) in 2004. The nine Groningen science shops function as university-based intermediaries between society and science. The aim of the 25th anniversary was to establish a better and more active interaction between society and the RUG. This was inspired by three developments:

1. The Dutch paradox: The scientific performance of the Netherlands matches that of the US. However, utilization of Dutch scientific capacity lags far behind that of the US. It seems that in the Netherlands the transfer of scientific research to the users is relatively difficult.
2. Establishment of a national innovation platform to strengthen the innovation performance of the Netherlands: Such innovation can only be achieved by close cooperation between industry and university.
3. Increasing pressure on university staff to perform in the areas of international research and higher education in combination with the lack of incentives to transfer knowledge to society.[1]

To examine the relationship between the University of Groningen and society, the science shops, in cooperation with the local news paper, 'Dagblad van het Noorden', invited representatives of society to visit five faculties and discuss the position of societal concerns in scientific research[2]. The conclusions of these meetings were published in a single issue magazine by Koninklijke van Gorcum BV[3]. Finally, the science shops organised a conference where the two groups met and intensively discussed matters.

Thanks to these efforts better insight was gained into the interrelationship between society and university. One conclusion was that performance measurement in the area of knowledge transfer to society should improve considerably and that incentives should be developed to improve knowledge transfer. To realise this goal, 'proxies' should be used to measure the transfer of knowledge, such as the 'social citations of universities', as Veenhoven and Topcu suggested.[4]

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[1] Although the 'Law of Higher Education and Scientific Research' points out that the transfer of knowledge to society is one of the three core university's responsibilities, only the quality and quantity of scientific research and education is periodically evaluated, but the university, and therefore its staff members, is not forced to justify or quantify its contribution to society.

[2] To prepare the meetings, students examined the relationship between society and the content of PhD-theses of these faculties.

[3] Wetenschapswinkels Groningen en Dagblad van het Noorden, Maatschappij op Visite: wetenschap op de korrel, Koninklijke van Gorcum BV, Assen, October 2004.

[4] They measured the knowledge transfer by assessing how often non-scientific media referred to scientific information that originates from the university. Such references include, for example, articles about university research and interviews with university scientists in quality newspapers or government publications (R.

This research adds another aspect to the measurement of university-society interaction and the development of indicators to measure university-society interaction. The authors do that through the analysis of knowledge transfer from the university to industry by contract research.[5] Their analysis shows clear differences in success between universities and faculties. Thus new information is added to the evaluation of university-society interaction.

The use of good indicators could be the first step in developing an incentive to enhance the transfer of knowledge from university to society, and in helping to solve the Dutch paradox.

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Chairwoman Science Shops, University of Groningen

Veenhoven en F. Topcu, `Maatschappelijke citaties van universiteiten, vermeldingen in overheidspublicaties en kranten', Erasmus universiteit Rotterdam, notitie t.b.v. discussiebijeenkomst Maatschappelijk publiceren voor de kennissamenleving, Stichting Weten en Science Alliance, Amsterdam, 24 juni 2004).

[5]In Dutch: Derde geldstroomonderzoek.

Abstract

In 2001 the European Council in Lisbon set the strategic goal of transforming the European Union, (EU) by 2010, into the most competitive and dynamic knowledge-based economy in the world. A comprehensive restructuring of the European research landscape towards a true internal research market is needed to create high levels of mobility, competition, and research excellence within the EU. An important role in this restructuring process has been identified for the European universities, which are seen as the 'engines of growth' for the economy. Within Europe scientific researchers conduct high quality research, implying that sufficient amounts of knowledge is created, nevertheless, it appears to be that the transfer of that knowledge to industry is hampered, for Europe lags behind the US and Japan in terms of innovativeness. The apparent 'mismatch' in industry-science relations, has become known as the "European Paradox" (EC 2002).

The traditional view of the university as the cornerstone of scholarly work, research and teaching is now being challenged by a more proactive view that sees the university as a central actor in the process of innovation responsible for, and expected to achieve, knowledge transfer to industry. This study tries to shed new light on this topic in two ways: first, the progression of research activities at the university level within the Netherlands is analysed. Data of the Association of Universities (VSNU), covering the period 1992-2001, is used to assess the competitiveness of the University of Groningen (RUG) opposed to the other main Dutch universities. Second, the evolution of contract research at the RUG during the 1990s and early 2000s at the faculty level is examined. A database consisting of 2,698 contracts over the period 1992-2003 is used to clarify the differing third stream research activities carried out at the 8 RUG faculties, which are actively involved in this type of research. We used third stream contract research as a proxy for university-industry interaction; after having hypothesised a positive relation between contract value/duration and a faculty's contracting experience. In addition, interviews conducted with each faculty's 'third stream' coordinator, about the respective faculty's third stream performance, provide in depth information about the underlying forces at work within the research community in Groningen.

The main findings of the Dutch university analysis are that the RUG is underperforming in terms of research in and output according to its size, and that the university's third stream research activities in relation to the total research activities are the lowest of all universities in the analysis. The somewhat disturbing results, in relation to the Lisbon Agenda, provide rationale for a revision of the university's current policy concerning third stream research. In order to make the RUG more 'entrepreneurial' the analysis, about the 8 RUG faculties, describes the university's current state of entrepreneurialism and all the problems faced by the faculties. The analysis exposes 'unintended' consequences of the current policies and finds a positive learning effect within the ('experienced') faculties with an above average amount of

contract activities. Indications are that the 'ivory tower' at the RUG is slowly crumbling and that sufficient scale and scope for third stream research appears to be present.
Considering the information and evidence presented in this paper it is not the question if the Dutch universities will become more 'entrepreneurial', but more when. By acknowledging this process the RUG needs to act quickly in order to regain some of its competitiveness.

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1 Introduction

In the late 1970's and early 1980's there was a continual slowdown in productivity growth and a related decline in the competitiveness of firms in high-technology industries. An alleged cause of this downturn in economic performance was a decline in the rate of technological innovation. Concerns regarding these damaging trends were particularly strong in the United States and encouraged a major re-examination of the goals and tactics of various aspects of U.S. technology policy. One dimension of innovative activity that was believed to be in strong need of reform was university-industry technology transfer. With the upcoming technological success of Japanese firms several leading experts on technology had stressed that American firms were not commercialising university-based technologies at a sufficiently rapid rate to maintain the nation's technological leadership.

Theoretical and empirical work in innovation-economics literature shows support for the use of scientific knowledge by creating and maintaining university-industry relations as a way that positively affects innovation performance (OECD 2000). This has led governments throughout the world to launch various initiatives to establish closer links between universities and industrial innovation. As a result, universities were stimulated to rethink their roles and activities in society. The traditional view of the university as the cornerstone of scholarly work, research and teaching is now being challenged by a more proactive view that sees the university as a central actor in the process of innovation responsible for, and expected to achieve, knowledge transfer to industry.

This movement away from the university's core mission has been portrayed in the academic literature as the birth of the 'entrepreneurial university', which, via the development of 'third-stream activities' or its 'third mission', will become the new engine of growth (OECD 2002). Universities are unique, as they take part in all processes that nowadays knowledge society is largely dependent on for its growth and competitive edge, namely: the production of new innovations, its transmission through education, and on its use through new industrial processes and services. Essentially, the new entrepreneurial university must contribute to innovation through knowledge transfer activities such as patenting, creation of spin-offs, development of technologies, etc.

Nonetheless, there is still disagreement about the net value of these new activities, especially from a university standpoint. There are scholars who criticize the concept of the entrepreneurial university because it will face long-run negative effects. Nelson (2001) argues that a major drawback of greater commercialisation of university research is its potential degradation of the culture of "open science" (Dasgupta and David 1994). Hence, open science

refers to the free exchange and dissemination of new ideas among faculty members and students. In a similar way Blumenthal (1997) argues that increased commercialisation of university research can also delay the publication of scientific findings and reduce the willingness of faculty to disclose their research agenda and results.

Although there is a large and still growing amount of literature on university-industry relationships, there is very little empirical research assessing and evaluating in a systematic way the importance and consequences of the new activities carried out by universities. At the European level, if we exclude the results of the Policies, Appropriability and Competitiveness for European Enterprises (PACE) survey that asks firms about the goals of innovation, external sources of knowledge, and barriers to profiting from innovation, and the Community Innovation Surveys (CIS) where limited information on the role of universities and public research centres is available, there is little evidence left.

This study aims to shed new light on the topic in two ways: first, we examine the progression of research activities at the university level within the Netherlands. By drawing from data of the Association of Universities (VSNU) we determine the competitiveness of the University of Groningen (RUG) opposed to their university counterparts in the Dutch university landscape. Second, we examine the evolution of contract research at the RUG during the 1990s and early 2000s at the faculty level. We analyse the contracts carried out by researchers employed by university faculties on the basis of an original database that includes 2,698 contracts signed by the RUG during the twelve year period 1992-2003. After looking at overall trends, we characterise the contracts in terms of their duration, value, and examine the evolution of these characteristics during four subperiods. In the end we will converge the results of the two parts and discuss the key differences in research performance and third-stream activities within faculties motivated by interviews with the 'third-stream coordinators' of each faculty.

2 University-Industry Relationships

University-industry relations (UIR) refer to the different types of interactions between the university and industry sector that are aimed at the exchange of knowledge and technology. Henceforward, the industry sector refers to both the industrial- and services environment. Even though universities are increasingly expected to contribute to the economic performance of their home countries, it has yet been difficult to empirically trace the direct effects of universities on industrial innovation because the relationship between universities and firms is mediated by a complex set of overlapping interactions and institutions (Salter & Martin, 2001; Jacobsson, 2002). In UIRs formal, more quantifiable, relations are supported by a multitude of informal contacts, personnel mobility and industry-science networks on a personal and organizational base. These informal contacts and human capital flows are ways of exchanging knowledge between enterprises and public research, which are more difficult to quantify, but nevertheless extremely important and often a mechanism for initiating further formal contacts (Matkin 1990).

Although the effects of UIR on economic performance have been hard to assess, the relationship between universities and industrial innovation can be a clear and tight one in industrial sectors such as: aerospace, biotechnology, microelectronics, pharmaceuticals, organic and food chemistry. These industries are "science-based" in the classic sense and have since their start relied heavily on advances in basic research to flow directly into their innovations. On the other hand, there are industries, the so-called non-science based industries as textiles, where the relationship appears to be distant and weak (Klevorick, Levin, Nelson, & Winter, 1995).

2.1 A Rising Trend

The recent intensification of the interaction and co-operations between curiosity-driven scientific research and profit-driven business research owes much to the following interrelated factors (OECD 2002):

- Technical progress accelerates and markets expand exponentially in areas where innovation is directly rooted in science (Biotechnology and Information Technology).
- Industry demand for linkages with the science base increases more broadly as innovation requires more external and multidisciplinary knowledge, and more fierce competition forces firms to save on R&D costs while seeking rapid access to new knowledge.
- Increasing budgetary stringency forces universities and other public research institutions to seek external sources of funding and are thereby encouraged to carry out research financed by industry. Indeed there is a clear trend of a growing share of funding of Higher

Education R&D expenditures (HERD) by the business sector while the total public share is steadily declining.

2.2 The European Struggle

Despite these recent intensifications of relationships and the presumed advantageous literature on UIR, there still seems to be a fairly large gap between high scientific performance on the one hand and industrial competitiveness on the other hand within Europe. It is noteworthy that this gap is mainly attributed to low levels of industry-science relations (ISR), what has become known as the "European Paradox" (EC 2002). In this regard, ISR refer to relationships between industries and both universities and public research institutes, whereas UIR only refers to linkages between industries and universities.

Polt (2001) concludes in line with the "European Paradox" doctrine, that within the EU insufficient ISRs typically do not reflect a lack in supply of scientific knowledge. Low levels of ISRs in EU member states can be attributed mainly to a lack in demand at the enterprise side, i.e. a specialization on innovation paths that do not require scientific knowledge or expertise, and to a lack of incentive structures and institutional factors at the science side. An OECD (2003) report on the competitiveness of the Dutch innovation system concluded that the favourable score on public research output (patents and scientific publications) contrasts with the score on economic output (labour productivity growth, improved sales) pointing to inefficiencies within the innovation system. The cause of these inefficiencies, as they argue, can be largely attributed to the insufficient co-operation between higher education and industry, what is perceived as the main weakness of the Dutch innovation system, and lies in the financing of universities. Despite all budgetary stringencies pursued in the last years, basic institutional financing still accounts for a very large share of total university funding (around 70 %). Moreover, the share of funds that are granted on a competitive basis by NWO is relatively low (less than 10%), as is the share of business in total funding (about 20%). In order for university research to be more responsive to innovation-driven demand for scientific and technological knowledge, the funding system should encourage more research industry-science partnerships. On the other hand, if you compare the 2003 OECD figures with the weighted averages presented in table 2.1 there has been a significant advancement in the spread in sources of funding at the benefit of these partnerships in the Netherlands. But, if it is true that the Netherlands performs relatively well opposed to the other countries, doesn't that make the paradox even more contradictory?

Table 2.1 *Higher education expenditures on R&D for 7 EU countries (1983-1997)*

	Total public share	General university funds	Direct government funds	Business share	Foreign	Non-profit organisations	Other income
1983	94	68.3	25.7	2.9	0.6	1.5	1.1
1989	89.9	60.2	27.7	5.4	1.6	2.3	1.2
1993	87.7	60.1	26.6	5.8	3.2	3.7	1.8
1997	84.6	57.9	26.8	6.4	3.5	3.8	1.7

Note: Denmark, France, Germany, Italy, Ireland, the Netherlands, and the United Kingdom.
Source: OECD (2002)

The requisite to tackle the "European Paradox" and the increased concern that Europe's innovation performance is loosing track on its main competitors (US and Asia), has led the European Council in Lisbon 2000 to set the strategic goal of transforming the European Union by 2010 into the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion. Furthermore, a restructuring of the European research landscape towards a true internal research market characterised by high levels of mobility, competition, and research excellence will provide a strong base for Europe's future.

2.3 Demand and supply of university-industry relations

In order to have a better understanding of the complexity surrounding UIRs you need to have knowledge of the forces that drive the interaction between the main actors and what the necessary framework conditions are in order to funnel these interactions. Naturally, University-industry relations, as any market relation, require as necessary conditions both a demand and supply for such links but more importantly also an institutional context in which those demand-supply conditions can flourish.

According to a variety of literature (Arundel & Geuna, 2000; Cohen et al., 2002; Mohnen & Hoareau, 2003: Veugelers & Cassiman, 2003), the demand for University-Industry Relations often requires the presence of large, domestic firms in high-tech areas. The argument pointed out in this research is twofold: 1) larger firms are more likely to have the necessary in-house capabilities to effectively interact with science. This is because large firms often have separate R&D departments, are more likely to employ university-trained staff, and are able to dedicate larger financial resources and time to build and maintain links with universities. 2) The domestic nature of the firm is critical since national affiliates of foreign-owned firms often may not carry out the type of research which strongly relies on the production of new scientific knowledge, i.e. research on completely new products, materials and technologies. Nevertheless, smaller high-tech firms often play a complementary role on the demand side. The level of interaction in UIR strongly depends on a firm's absorption capacity and

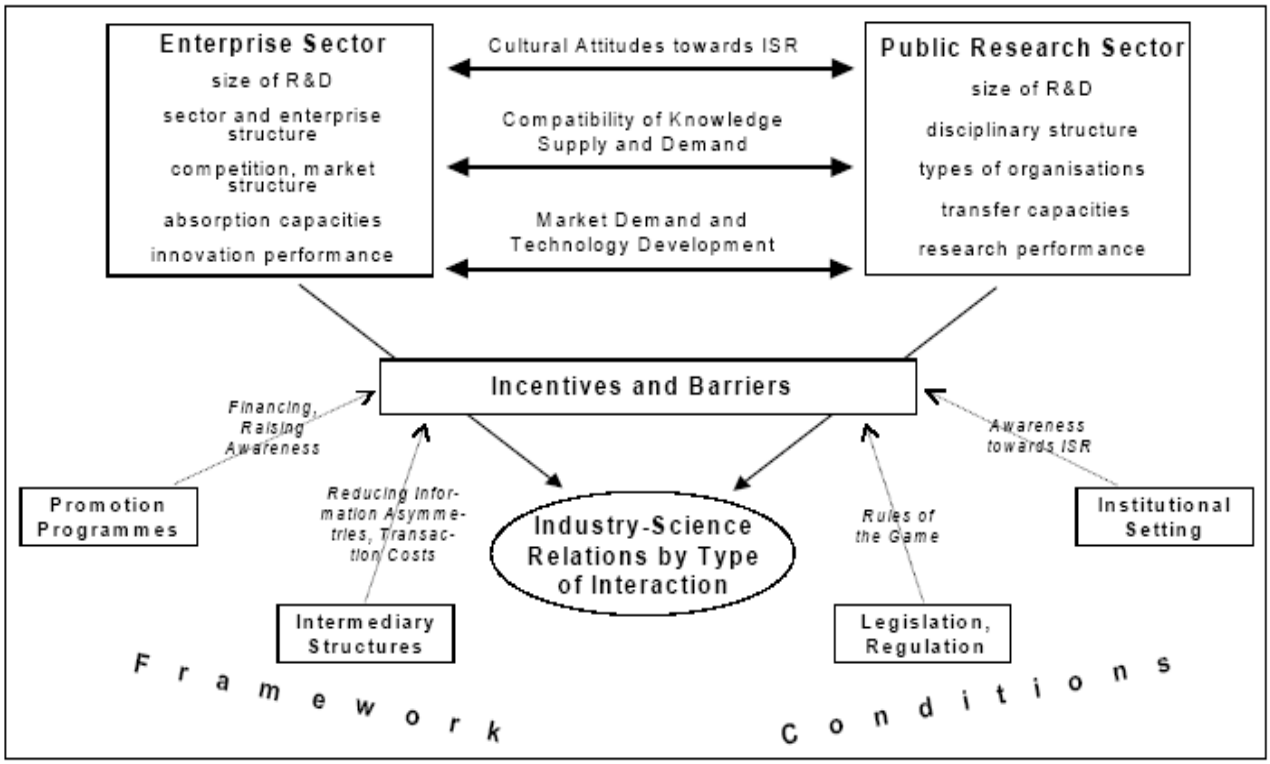
involvement in innovation activities. Since quite a lot of those smaller innovative firms are spin-offs of university research, it assures them right from the start of the absorptive capacity needed. Accordingly, there exists a dynamic relationship between large R&D intensive firms and smaller high-tech firms as to generate a demand for industry-science links.

The supply factor for university-industry relations relates to a well performing and competitive university base. Fundamentally, in order to have a competitive university base on a national level it should cover a suitably wide portfolio of scientific fields in which research excellence is promoted. The primary advantages of universities to engage in UIR should be largely seen in the light of direct sources of revenue to the university, from licensing and equity income, and indirect revenue sources, such as sponsored research, donations, and support from companies (Poyago-Theotoky et al.,2002). It is likely that universities can also benefit from "reverse" technology transfer (i.e., technology transfer that flows from firms to universities), enabling academic scientists to conduct better experiments, as a result of their interactions with industry scientists (Siegel et al., 2002). These alliances may also have a positive effect on the curriculum, as faculty members draw on their experiences with firms to provide instruction that is more relevant and more closely aligned with the needs of high-technology firms (Stephan 2001).

At all times a match of knowledge supply and demand provides a necessary condition for establishing relationships in innovation activities. However, even if there is supply and demand for UIR, effective university-industry interactions may not appear. The degree to which this potential is utilized also depends on the framework conditions inside the national innovation system.

A 2002 report Benchmarking Industry-Science Relations provides a good review of the topic of this paper. It underlines that:
"Industry Science Relationships are not simply transactions mirroring a clear-cut division of labour in the production of knowledge. Rather, they represent an institutionalised form of learning that provides a specific contribution to the stock of economically useful knowledge"

The diagram below summarises the conceptual framework used by the benchmarking report.



Source: Benchmarking Industry-Science Relations in Europe. The Role of Framework Conditions. (2001).

This model illustrates that UIR can be characterised along three dimensions affecting UIR performance in a specific country. Firstly, the characteristics of the main actors: firms and the public research sector, including universities. Secondly, framework conditions or incentive structures such as public promotion programmes, intermediary structures, legislation and regulations, institutional settings, and thirdly the nature of the channels of interaction: contract research, consultancy and services, knowledge spillovers, cooperation with firms for teaching, and labour mobility.

Hence, high levels of interaction occur when industry demand is high; incentive schemes in science are well developed; the legislation is favourable; and public initiatives to foster university-industry relations are developed along a long-term perspective.

2.4 Contribution of the study

This study mainly refers to the university side of the spectrum where we analyse contract research as the type of communication channel used by faculties to establish links with firms and other institutions for over a decade (1992-2003). We base our analysis on a portfolio of contracts involving 8 faculties at the University of Groningen crossing various scientific

fields. To the best of our knowledge this study is unique by its nature as there has not been any scientific publication yet that analysed contract research at a university level in the Netherlands. We are also the first to use the "contract research database" for empirical research at the University of Groningen.

Nonetheless, our purpose is not to analyse the potential positive or negative effects of university-industry relationships on the university, but to characterise in an empirical way the importance of the phenomenon at the faculty level. Previous to the analysis at the faculty level, we will develop a descriptive analysis of the research performance of the RUG at the national level. Hence, we compare the RUG to other universities by looking at scientific output in terms of number of scientific publications over time and at scientific input in terms of FTE spend on research. In addition, it gives an idea about the research culture within the university and serves as a background at which we deepen the analysis to the faculty level.

University-industry relationships have always constituted a part of the activities carried out by some faculties at the RUG. As said in a previous paragraph, there have been multiple factors forcing a further intensification of interaction and cooperation's of the university base with industry during the '90s, this induced more faculties to carry out research for firms. Therefore, we could expect a mixture in intensity of contracting behaviour at the level of the faculty dependent on the historical involvement of the faculty in contractual research. Thus, the other element of originality is not to consider the university as a whole, but to underline differences in contracting behaviour of faculties and to identify the existence (or not) of core faculties in signing contracts.

The last original contribution relates to the empirical exploration of whether the experience of faculties with firms has affected the characteristics of the portfolio of contracts established by these faculties with external partners. We would suggest that 'experienced' faculties with a greater understanding in contracting through organisational learning will have a contract base with a trend towards long-term research contracts with relatively higher monetary value, rather than short term low-value contracts. On the other hand, if the portfolios of 'experienced' and 'non-experienced' faculties show comparable characteristics, we would suggest that contractual relations at the faculty level exhibit a demand-led process of contracting, even though both influences can co-exist.

3 University of Groningen: A general introduction

The University of Groningen is one of the oldest classical research universities in Europe with a long tradition of academic excellence. Since its inception in 1614 it has given birth to more than 100,000 graduates. The university is one of the largest of the 14 universities in the Netherlands offering the highest form of Dutch education, with approximately 20,000 students enrolled in more than 160 bachelor and master programmes. Every year around 775 students are studying for their PhD, about 2,500 students graduate from the university, and some 250 PhD-students defend their doctorate thesis.
During the 390 years of its existence, the university has evolved from a university in medical sciences towards a broad university covering a wide range of research fields and attracting students and staff not only from the Netherlands, but from more than 90 different countries worldwide, which illustrates the international orientation of the university. The influx of international students, both exchange students and regular students, represents around 10% of the total amount of students. Naturally, the European Union is the largest contributor with 46,4%, outside Europe, the university attracts a significant amount of students from various Asian countries, representing 29,7 % (Annual Report 2002).
Although these figures are not outstanding compared to other large universities in the Netherlands, the university does take a unique place in the Dutch university landscape as being the single university in the north of Holland and thereby shaping a research environment that serves as one of the main pillars of the northern knowledge-based economy. The university has established a number of specialist centres that provides a platform for mounting research activity and a vehicle for developing links with outside organisations through consultancy and short courses. This “marketed” outward look of the university has led to closer ties with business, government bodies and other knowledge institutes in the region that induces the creation and diffusion of knowledge so important for economic growth at the local and national level.

Among others, the next section provides a critical analysis of the above said: Is the RUG really moving away from what once was seen as the cornerstone of scholarly work towards an entrepreneurial university that fosters UIRs combined with science parks and specialist centres as they argue, or do key research figures show a different picture?

3.1 Research Indicators

As Europe is striving to become the most dynamic knowledge-based economy, the creation and diffusion of knowledge are key concepts of economic activity and important sources of competitiveness. University researchers are among those highly qualified people involved in both processes. First, research excellence leads to new innovations and consequently expands

the current stock of knowledge. This newly acquired knowledge is codified through scientific publications and patent applications. Second, researchers repeatedly use these scientific publications as a channel to disseminate knowledge and to make it available to third parties for further usage. For this reason, "scientific publications" is often used as a performance indicator for the competitiveness of a nation's economy, as it reflects the research capacity and knowledge pool of a country (EC 2002). In this analysis we restrict the meaning of "scientific publications" as a performance indicator (output variable) that measures the competitiveness at the university level, as it reflects the "total research output" and knowledge pool of a university.

The total research output of a university comprises three streams of research activities, of which the establishment of UIRs is part of the universities third-stream activities, as mentioned in the introduction. However, note that third-stream activities also include relations with the public sector. The other two streams incorporate: 1) governmental funding by the Minister of OCW, and 2) research funding by the NWO. Unfortunately, the data used for the analysis does not make a distinction between scientific publications originating from either first, second, or third-stream activities. Alternatively, at the input side of the spectrum the number of scientific staff (FTE) employed in research is used. Here the data does make a distinction between FTE employed in the separate streams. This let us draw firm conclusions on the RUG's effort to establish UIRs in comparison to other universities.

Research Performance

The Info-Box supports the fact that the Netherlands has a good performance on scientific output at the European level. However, what university contributes most to this success? What is the competitive edge of the University of Groningen?

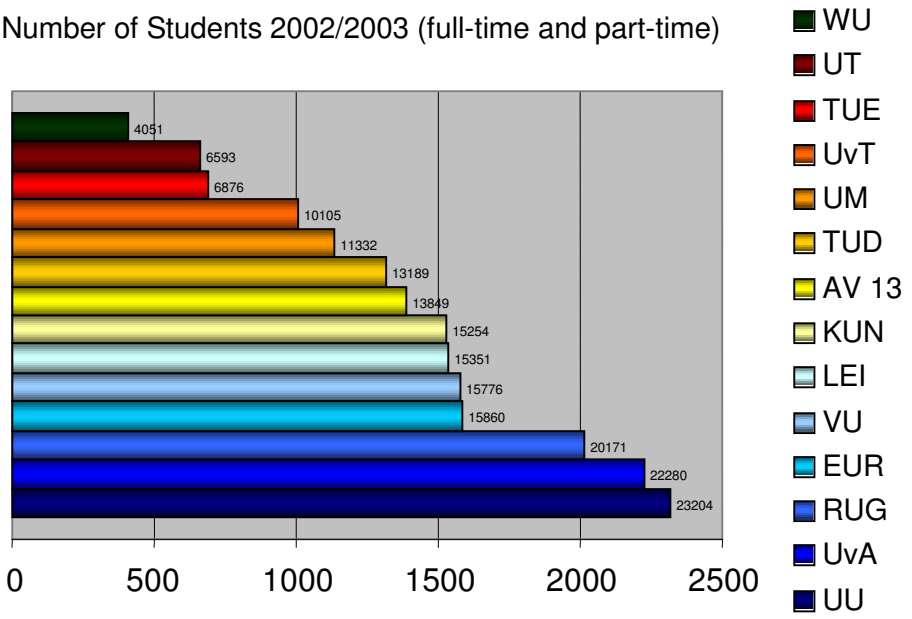
Info-Box

The report "Key Figures 2002", issued by the European Commission, illustrates that the Netherlands performs satisfactory with a 5th place, behind Finland, Sweden, Denmark and the UK, on the "*number of scientific publications per million population"*. More importantly, it has a second place behind the US on "*highly cited papers as percentage of total number of scientific publications"*, which is used as a proxy of the importance of research.

The descriptive analysis is based on data provided by the Dutch Association of Universities (VSNU), an organization consisting out of representatives of the 14 universities with the aim of reinforcing the position of scientific research and education. The database covers the time-

period of 1992-2001. Since none of the universities can be seen as strictly similar in size and scientific field it is decided to encompass only the universities with an above average (AV13) amount of students to at least limit the possible bias for size in analysing the data. Besides the University of Groningen, these universities are(see: figure 3.1): University of Utrecht (UU), University of Amsterdam (UvA), Erasmus University Rotterdam (EUR), Free University of Amsterdam (VU), University of Leiden (LEI) and the Catholic University of Nijmegen (KUN). A drawback of this decision is that the three potentially most innovative technological universities fall out of the analysis.

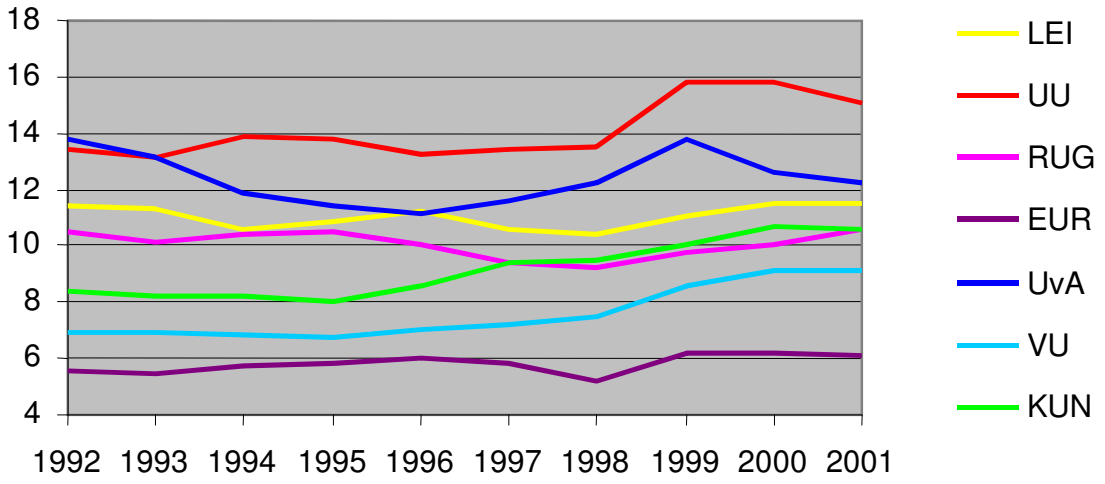
3.1 Number of Students 2002/2003 (full-time and part-time)



Research Input

Theoretically, all things equal, larger universities are expected to have generously proportioned pool of scientific staff and research facilities compared to smaller universities and likewise should have larger market shares in both scientific input and output. In figure 3.2 the "research input" market shares of the seven largest universities are calculated for the period of 1992 till 2001. These market shares represent the research input in all three streams of activities and tell something about the respective attitude towards scientific research at each of the universities. It illustrates that of the three largest universities (UU, UvA and RUG), the University of Groningen clearly lags behind its main contestants. Even smaller universities as Leiden and Nijmegen outperform Groningen. Where most other universities have expanded their research activities during the mid 90's, the University of Groningen has shown a gradual decrease in research activity from 1992 till 1998. Even though recent years show some signs of recovery back to level in the early nineties, its market share is still below of what could be expected with respect to its size.

3.2 Market share "research input" in FTE 1992-2001



Yet, these figures do not validate any remarks on the entrepreneurship of a university. There is an explicit distinction between first- and second-stream research compared to third-stream research. The former is the traditional mode of research where the need for scientific research mainly originates from inside the university, whereas the latter is the entrepreneurial mode of research supported by firms, governments and other public institutions. Although there is no solid measure for "entrepreneurship", the true entrepreneurial university can be characterised by high levels of third-stream research input compared to its total research input.

3.3 Third stream research input (FTE) / Total research input (FTE) 2001

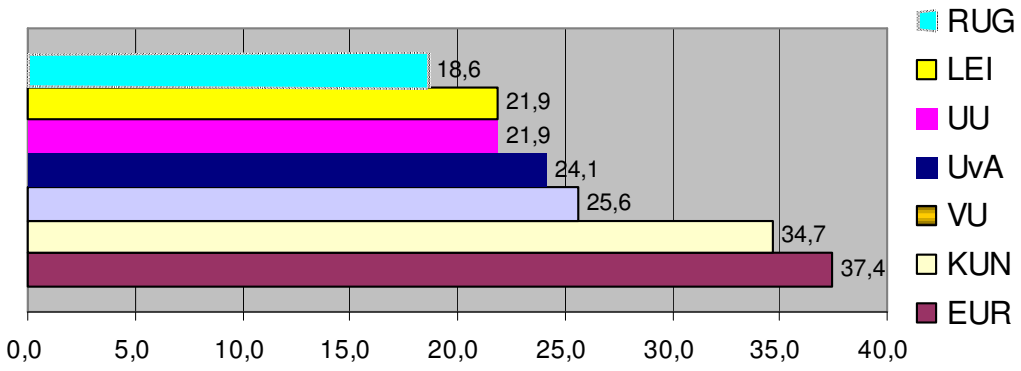


Figure 3.3 exemplifies a divergence between small and large universities. It provides evidence for the assertion that larger universities are relatively less entrepreneurial orientated and have a more traditional or classic approach to research than smaller universities. This analysis is further supported by the ratios of the other Dutch universities. For example, the technical

universities of Eindhoven and Twente have a ratio of respectively 28.7% and 27.1%[6]. Moreover, smaller universities, as Maastricht, have a ratio of approximately 33%, whereas third-stream research input at the University of Wageningen counts for almost half of the total amount of FTE spend on research. One of the main reasons for this to occur has to do with governmental funding (first-stream), where larger universities obtain proportionally more funding than their smaller counterparts and similarly spend more FTE in first-stream activities. This forces smaller universities to find additional sources of funding outside the direct environment of the university and provides them with the necessary incentives to engage in third-stream UIRs.

However, this can not be seen as the only justification for the conspicuous low amount of third-stream research input relative to total research input of the University of Groningen. In fact, after the University of Tilburg, Groningen has the lowest ratio of all universities. In absolute sense this picture does not alter dramatically. Where the largest three universities are both confronted with low incentives to directly engage in UIRs, the universities of Amsterdam and Utrecht still account for respectively 412 and 461 FTE, whereas the University of Groningen only employed 273 FTE in third-stream research in 2001. This possibly has to do with the research culture and attitude towards UIRs inside the University. We will discuss these issues more thoroughly in chapter 5.

Research Output

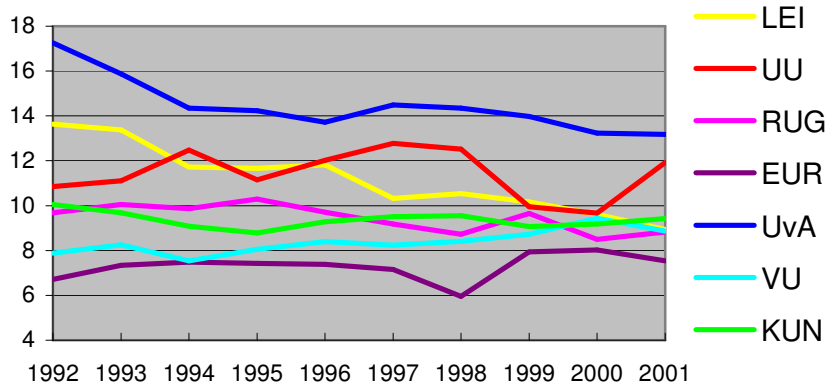
Since research input is expected to have a significant impact on output variables, one would expect the outcome of output in scientific papers to be aligned with the outcome of research input in FTE and accordingly the universities to have comparatively similar market shares. However, one critical point needs to be made: in despite of the fact that the data confirm a significant relationship between the two variables (Pearson correlation coefficient of .805 at the 0.01 level) it does not imply causation. The magnitude of the relationship only tells us that large values of scientific staff employed in research are associated with large values of scientific publications. There might, however, be other variables that could explain part of the correlation results (scientific fields, sources of funding, organizational setting etc.).

Figure 3.4 illustrates the amount of scientific publications per year for the same time period. Based on the above said, it might be expected that the universities of Utrecht and Amsterdam have been able to translate their dominance in research input to scientific output in terms of the amount of scientific publications. However, this is only partly true, the University of Utrecht shows with an average input market share of 14,1% a lower than expected amount of market share in scientific publications, average of 11.4%, which implies a low research-

[6] The Technical University of Delft could not provide any information.

productivity ratio. The University of Groningen has a rather modest performance, and has lost some of its competitiveness during the last 10 years, the market shares range from 9.7% in 1992 to 8.8% in 2001 with a small peak in 1995 with 10.3%. According to the 2001 figures Groningen is ranked 6th on top of the Erasmus University and close to the universities of Nijmegen and Leiden and the Free University of Amsterdam. Although the universities of Amsterdam and Utrecht have faced similar downturns in market share, they have been able to maintain their positions as most contributing universities to the competitiveness of the Dutch economy.

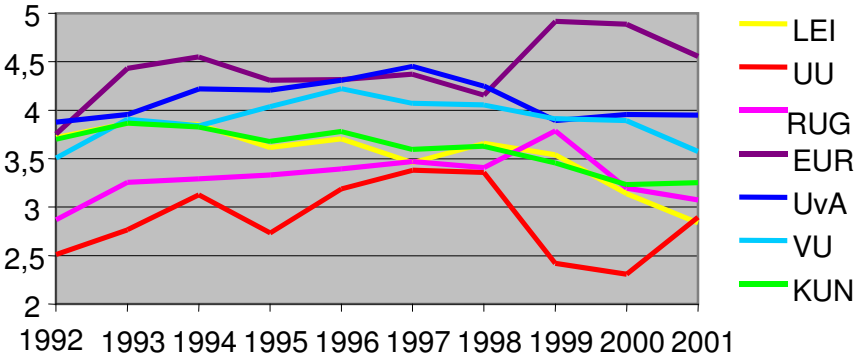
3.4 Market share "scientific publications" 1992-2001



Research Productivity

In research, just as in production, there is a common conjecture that larger units create 'static economies of scale' (i.e. greater output per unit input) and 'economies of scope' (synergy derived from conducting several related activities at the same time). This view is highlighted by Gibbons et al. (1994), he argues that there has been a shift in balance from 'Mode 1' research conducted by individuals or teams often drawn from a single discipline and working within a single organisation, to 'Mode 2' research involving greater external relations among individuals and teams, who are also likely to come from a wider range of disciplines and organisations. Consequently, larger universities ought to gain more economies of scale and scope resulting in higher research productivity ratios. Figure 3.5 illustrates the amount of output in scientific publications per FTE employed in research per university.

3.5 Research productivity (scientific publications/ input) 1992-2001



Remarkably, the Erasmus University, the fourth largest university, with the lowest market shares in both the input and output indicators, performs best when it comes to productivity. Despite the strong appearance of the University of Utrecht in the former graphs, it has not been able to gain any significant levels of economies of scale and scope and faces low productivity ratios. In contrast, the University of Amsterdam confirms its competitive edge. Since this graph is a combination of the two previous graphs it could not be expected to see any revitalization from the University of Groningen. Although its productivity ratio outperforms the University of Utrecht, it still lags behind in actual scientific publication rates, ultimately the indicator for competitiveness.

Conclusively, the University of Groningen underperforms according to its size. It is the third largest university with a broad spectrum of scientific fields, which provides a fruitful environment for up standard scientific research. However, for a number of reasons they have not been able to convert this research potential into pure scientific output. As the analysis shows a crucial rationale for this to transpire is the low level of FTE employed in research. An explanatory variable could be the large appearance of Alfa and Gamma related sciences at the RUG where the necessity of (contract) research is less apparent as with Beta related sciences. Alternatively, why should this be more dramatising for the RUG's research performance when other 'broad' universities, as the University of Amsterdam, are confronted with the same issue but are still able to foster research excellence?

More specifically, the involvement in third-stream activities is inferior compared to most other universities what characterizes the traditional view of the university. It is the authors' belief that this conservative strategy pursued by the university has caused its competitiveness to loose momentum in subsequent years. Although it is not our objective to investigate the "why" question at this stage of the paper, reasons for this could be found in: the

organizational setting, sources of funding, incentive schemes, or attitudes and perception towards research. These qualitative explanations will be covered in chapter 5 of the paper.

Critics to the analysis: contribution to society

The "Law of Higher Education and Scientific Research" points out that the transfer of knowledge to society is one of the three core responsibilities of a university. However, when analysing the research competitiveness of a university by using the single proxy "scientific publications", as done in chapter three, a significant dilemma lurks: in what way does the *quantity* of scientific publications relate to the *quality* of knowledge transfer to society?

Inherently, the university with the largest score on scientific publications does not necessarily have to be the university with the largest contribution to society through high quality knowledge transfer, i.e. scientific research can be publicized in relatively low-impact periodicals as opposed to high-impact periodicals. At this background Veenhoven and Topcu (2004) recently published a paper on what they refer to as "social citations of universities", where the social impact of a university is measured. They argue that the university's contribution to society is not only determined by the quantity of scientific publications, but more implicitly by the knowledge transfer through the use of non-scientific media to refer to scientific information that originates from the university. This includes, for example, articles about university research and interviews with university's scientists in quality newspapers and government publications. These references to scientific perspectives are called "social citations".

To carry out their research Veenhoven and Topcu used two databases: 'www.overheidspublicaties.nl' which covers all policy-documents of the central government, and the 'krantenbank' (www.lexisnexis.nl) which covers all articles published from 1992 in: de Volkskrant, Algemeen Dagblad, NRC Handelsblad, Het Parool, Trouw, de Telegraaf, and the regional newspapers of the GPD. From these two databases they selected all publications from 2003, and used the word "university" as a search criterion. Ultimately, they counted the number of publications in which knowledge was transferred by a university. In the case of government publications this took place 252 times, and 4800 times in quality newspapers of which they took a sample of 463. The results can be found in table 3.6 and 3.7 on the next page.

Table 3.6 *Number of social citations in "government publications"*

University	Amount	% of total	Per million euro budget
EUR	42	16.70	0.274
KUN	20	7.90	0.099
LEI	17	6.80	0.078
OU	0	0	0
RUG	14	5.60	0.055
TUD	7	2.80	0.022
TUE	0	0	0
UM	16	6.40	0.115
UT	17	6.80	0.113
UU	38	15.10	0.104
UvA	35	13.90	0.121
UvT	11	4.70	0.162
VU	22	8.70	0.104
WU	13	5.20	0.100
Average	18		0.099
Total	252	100	

Table 3.7 *Number of social citations in "quality newspapers"*

University	Amount	% of total	Estimation per million euro budget
EUR	66	14.3	4.45
KUN	30	6.5	1.54
LEI	32	6.9	1.53
OU	10	2.2	3.23
RUG	19	4.1	0.79
TUD	4	0.9	0.13
TUE	8	1.7	0.53
UM	25	5.4	1.87
UT	12	2.6	0.82
UU	47	10.2	1.33
UvA	87	19.0	3.12
UvT	39	8.4	5.93
VU	47	10.2	2.30
WU	17	3.7	1.35
Average	33.1		2.07
Total in sample	463	100.0	
Total in population	4,800		

In short, the results are just as dramatic as they are illustrative for the already feeble research performance of the RUG. In addition to its low level of competitiveness, the university's knowledge transfer to society through government publications and quality newspapers is also unsatisfactory both in an absolute sense but certainly in relation to its budget. On both

dimensions the university scores nearly half the average which, as Veenhoven and Topcu argue, says something about their *intention* to engage in knowledge transfer: little [7].

[7] In order to interpret the results correctly it has to be said that Veenhoven and Topcu are two sociologists at the Erasmus University Rotterdam.

4 Contractual Relationships

In the large body of literature, that analyse UIRs, expressions as the "entrepreneurial" university and the "commercialisation of university research" emerge repeatedly. Partially fed by the goals set in the Lisbon Agreement, national government officials experience an upcoming need to increase the interaction between universities and industries. The 'holy grail' of the knowledge driven society accordingly puts policymakers under pressure to take action.

In the last two decades various attempts to spur and achieve sustainable innovation have been made. First of all, the "linear model" of innovation, which simplistically assumes that increasing the funding of fundamental research is a sufficient condition to increase innovation. The European paradox exposes the unsuitability of this model by demonstrating that there is no lack of research excellence and quality research, but that the real problem lies in the low level of commercialisation of the created knowledge and the apparent inability to transfer this knowledge in an efficient and effective manner to the knowledge receiver. The decline in public funding of universities in the last two decades proves the linear model to be unfit for the job. The rejection of this model does not imply that it is unable to spur innovation; governments faced with increased budget restraints are left with no other choice than to seek other more economical policies in this area in order to achieve their innovation goals (Gibbons et al. 1994).

The second innovation model is labelled "Mode 2" research, which can be characterised by a more interdisciplinary, pluralistic or network approach to innovation, in contrast to the previous model where major corporate academic research institutions were less closely linked with other institutions (Mowery & Sampat, 2003). The latest model is called the "Triple Helix", just as in "Mode 2", it emphasizes on the importance of interaction with institutional actors. However, universities in the Triple Helix framework are assumed to take entrepreneurial activities as one of their core tasks, which "Mode 2" does not. Although the latter two models are theoretically very interesting, in practice, and especially in Europe, they are still hampered by significant institutional barriers to the commercialisation of research (OECD 2000, EC 2002). The major institutional barriers being the Intellectual Property Rights policy and the barriers arising from incentive schemes that are present (or not) in academic research.

Policy initiatives to create effective incentive schemes have been implemented, favouring the formation of regional economic clusters (science parks), the facilitation of academic spin offs and the implementation of patenting and licensing programmes. These initiatives show the tendency of policymakers to selectively "borrow" policy instruments from other countries in

which they have proven to be successful. However, the diverse institutional context of the different countries is bound to affect the respective instrument's effectiveness. Felsenstein (1994) and Wallsten (2001), show that there is ample evidence that science parks positively influence the contributions of universities to local development and innovation. Cohen et al. (2002) found evidence suggesting that in the majority of industries patents and licenses comprising from publicly funded institutions were of marginal importance when compared with publications and informal interactions with university researchers. The consequences of "borrowing", combined with the present difference in objectives between universities and industries, highlighted by Malinen & Toivonen in their 1998 paper, illustrates the complexity of the situation.

In the Netherlands, according to the "Law for Higher Education and Scientific Research (WHW), universities not only have to provide education and perform research but are also obliged to transfer knowledge to society. The current institutional structure does not encourage universities to perform the latter task and leaves initiatives in this direction un-rewarded and underdeveloped. The lacking incentives to transfer knowledge to society becomes more problematic with the increasing pressure on universities to perform (Veenhoven & Topcu 2004).

Chapter 3 taught us that the competitiveness of the University of Groningen is loosing momentum and that a part of the explanation can be found in the traditional approach to research where third-stream "commercial" activities are relatively underdeveloped. This section, therefore, examines more deeply the importance and evolution of RUG faculties' third-stream activities. We expect a strong divergence in contractual relationships between various faculties resulting from differing policies, incentive structures, and institutions as discussed above. After looking at basic contractual characteristics, we subsequently develop theory and hypotheses followed by the statistical methods and results. The final results will be underlined through discussing the main explanatory variables strengthened by qualitative research in chapter 5.

4.1 The evolution of contractual activities

Our analysis covers a period of more than a decade from 1992-2003. The data set was developed by the Head Financial Administration of the RUG and registers all contracts between the RUG and any outside firm or institution. The internal regulation of the university requires that all contracts must be scrutinised and registered by the Head Financial Administration after a signature by the rector of the university, which gives us confidence as to the exhaustiveness and validity of the contracts registered. The original database includes 2,698 contracts over a twelve year period. After an advanced selection for 'faculty contracts',

i.e. contracts that fall under any of the university's faculties, there are 2,592 contracts left, of which 411 EU contracts.

The analysis focuses especially on the non-EU contracts, which are contracts that are not part of any of the European Union framework programmes. Unfortunately, the database could not provide us information on whether a firm or institution is the receiver of the contract or if the contract has a more second-stream NWO character. As the unit of analysis is the firm or public institution and the RUG faculty we had to exclude the EU contracts from the analysis, despite their importance. Yet, its large average weight of 15.7% of total contracts per year can be seen as an indicator that the RUG is an internationally orientated research university.

4.1 Number of contracts 1992-2003

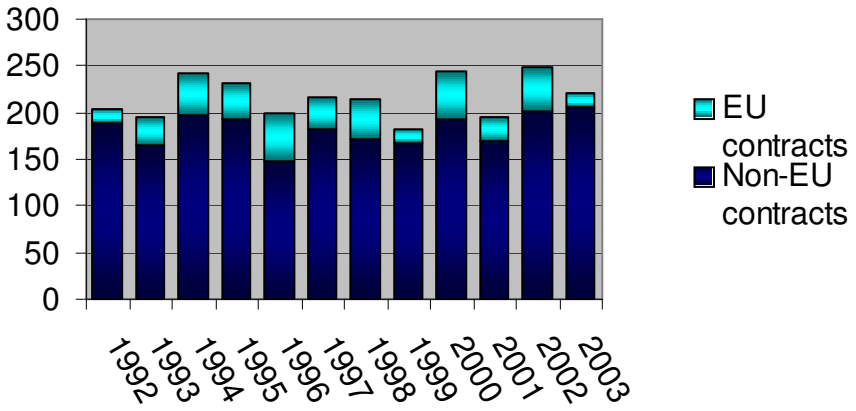


Figure 4.1 shows the aggregate number of contractual relationships over the period 1992–2003. The number of contracts reaches a first peak in 1994, after which there is a gradual decrease until 1999. This peak is attributable to a relative strong increase in non-EU contracts but also to the augmenting large weight of EU contracts. If you take into account EU contracts only, there is another peak in 1996, which, when measured against total contracts, counts for 25,6 % of all contracts signed during that period. However, this peak is counterbalanced by a strong decrease in non-EU contracts. After 1999, there are two more major peaks, in 2000 and 2003, which show similar compositions between EU and non-EU contracts as the peak in 1994. In all three peaks the EU-contracts covered around 19-21% of the total amount of signed contracts during that year. The 11.8% decrease in 2003's contractual activities can entirely be attributed to the low levels of non-EU contracts, which only took 6.8%. Over time, the contractual relationships of the RUG show a compound annual growth rate of 0.7%.

The RUG acknowledges in their 2002 annual report that the increasing budgetary strictness in recent years have forced them to seek external sources of income and are thereby encouraged to carry out research work financed by industry and establish long-term university-industry relationships. At first sight the compound annual growth rate of 0.7 % does not support their strategy, however, since the downturn in 1999 there has been a gradual increase in university-industry activities. Although the pattern during 1999-2003 indicates heavy fluctuations with a rise of 34.1% in 2000 followed by a decrease of 19.7% in 2001 etc., on average this period points out a compound annual growth rate of 4.2%.

The main active faculties in contractual activities

All contracts in the database are assigned to the respective faculties, or in a broader sense: research domains, where the contracts are executed. The RUG has a total of 10 different faculties covering a wide variety in research domains, of these 10 faculties, 8 are actively involved in establishing contractual relations with firms and public institutions: Spatial Sciences, History and Arts, Management & Organisation, Economic Sciences, Medicine, Psychology & Social Sciences, Law and Mathematics & Natural Sciences. The broadly defined Mathematics & Natural Sciences faculty includes contracts in Chemistry, Physics, Biology and Pharmacy.

In order to find an evolution pattern of contractual relationships in the remaining part of the section, we have developed an analysis of the changes in characteristics across four sub-periods: 1992-1994; 1995-1997; 1998-2000; 2001-2003. Although, grouping data values into intervals causes some loss in information, it does let us examine and view the shape of the distribution and the modal pattern more steadily. Table 4.1 shows the concentration rate of research contracts of the Faculty of Medicine (C1) and for the faculties of Medicine, Mathematics & Natural Sciences, and Psychology & Social Sciences, grouped under C3. What emerges is the overwhelming leadership of the Faculty of Medicine, and the relative weight of the Faculty of Medicine, Mathematics & Natural Sciences, and Psychology & Social Sciences.

Table 4.1 *Contracts by faculties - 4 sub-periods*

	1992-1994	1995-1997	1998- 2000	2001-2003
Number of faculties	8	8	8	8
Number of contracts	551	524	530	576
C1*	0.37	0.38	0.46	0.63
C3**	0.88	0.81	0.87	0.89

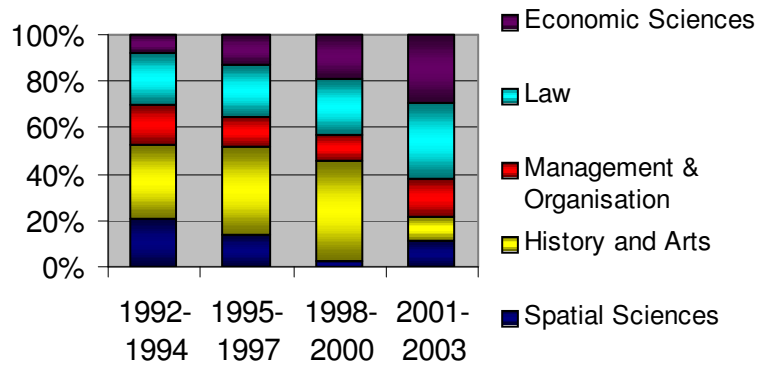
* C1 concentration rate research contracts of the Faculty of Medicine.

** Faculty of Spatial Sciences, History and Arts, Management & Organisation, Economic Sciences, Psychology & Social Sciences, Law

It is interesting to see the progression of contractual activities at the Faculty of Medicine over the four sub-periods. Over the first two periods, the relative number of contracts was relatively constant around 37 %, whereas, the consecutive periods the amount of medicine contracts increased to the total number of contracts. On average, over the whole period, the number of contracts in Medicine accounts for 46% of the total. The proportion of EU contracts in Medicine is far below the average of 15,7% of the proportion of EU contracts in the total number of contracts signed by all faculties. In other words, Medicine does not benefit more from EU support than the average faculties. The reason for the strong presence of the Faculty of Medicine should be found in the traditional strong relationship the faculty has with the Academic Hospital Groningen. More troubling is the stable concentration ratio for the 3 most important faculties in terms of contractual relationships. A significant increase in C1 and a steady C3 ratio implies that the contractual activities of the Faculty of Mathematics & Natural Sciences, and Psychology & Social Sciences have dramatically decreased in the consecutive periods indicating a more asymmetric evolution of contractual relationships over time.

A second implication of the steady C3 ratio is that the evolution in contractual activities of the 5 smallest faculties (1-C3), at first sight, does not show any progression over time, despite a small upturn in the second period. However, a detailed look at figure 4.2 points out that the composition within this segment has changed considerably.

4.2 Faculties with low contractual relationships

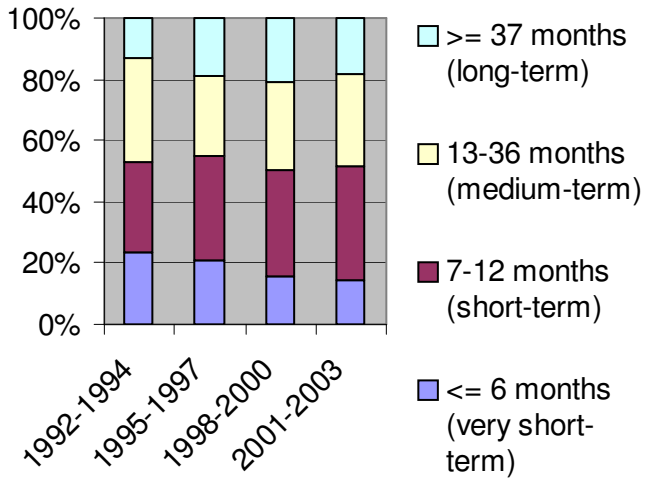


Where in the first period the faculties of History & Arts and Spatial Sciences accounted for more than 50 % of the remaining 12 % of the total quantity of signed contracts, this has decreased significantly over time. This is mainly due to a strong pullback in contractual relations within the Faculty of History & Arts. On the other hand, the faculties of Economic Sciences and Law have significantly increased their contractual relationships with firms and institutions as a percentage of the total amount of contractual relationships.

Evolution of contract duration

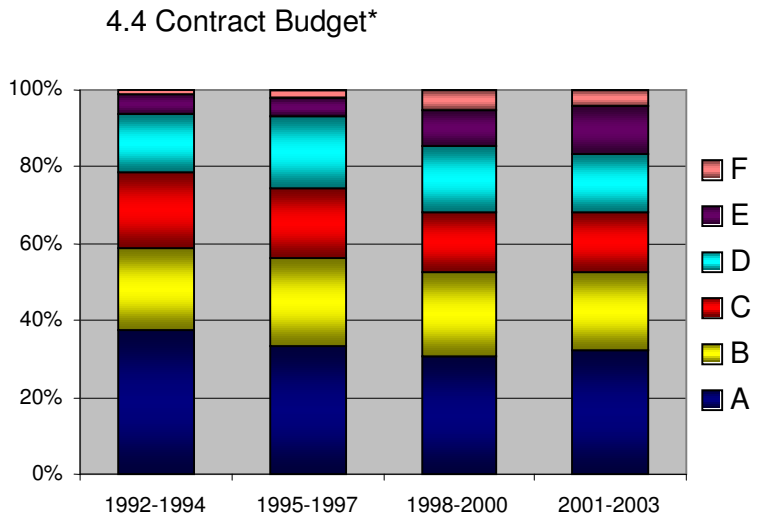
In general the percentage of contracts that last less than a year, over the four sub periods, is relatively stable, approximately 52%. However, figure 4.3 highlights a trend towards short-term contracts at the expense of very short-term contracts. Alternatively, in the first three periods there seems to be a trend towards long-term contracts with a duration longer than 37 months opposed to medium-term contracts, but the last period slightly weakens this tendency. The exact interpretation of these evolutions is difficult and can lead to a variety of explanations but these will be hard to justify empirically. It could be that faculties under budgetary pressures move away from very short-term contracts and have their focus more towards the establishment of stable relationships over time. On the other hand, firms and institutions might be reluctant to involve in too long partnerships regarding the insecure economic outlook and the economic slowdown in recent years. This might also partly explain the rise in very long-term contracts since the beginning of the 90s when we experienced a flourishing national economy.

4.3 Contract length



Evolution of contract value

We have classified contracts into six classes according to their budget from small to large: A to F. Classes A and B include the low-budget contracts, C and D medium-sized ones and E and F the high-budget contracts. Figure 4.4 indicates a similar pattern that emerged for contract length (see figure 2.3). Over the four sub-periods, the high-budget contracts tend to increase in number, while the number of low-budget contracts and medium-sized contracts decreases. The similarity in patterns of both contract length and contract value indicates a positive correlation, where long-term contracts are associated with higher budgets. This notion is confirmed by the Pearson correlation coefficient of .623 (2-tailed), which is significant at the 0.01 level.



* Due to reasons of confidentiality we cannot list the original budget classes.

4.2 Theory and hypotheses development

The previous analysis indicates that that the number of contracts of RUG faculties with firms and other institutions has not increased dramatically during the period under consideration, there, nevertheless, is evidence that does indicate a dramatic shift in each faculty's contract portfolio composition, in terms of duration and monetary value. We hold two different explanatory hypotheses responsible for these changes in portfolio composition based on 'Knowledge Transfer' theory provided by Husman (2001).

At the core of any UIR lies the knowledge transfer process. The ideal outcome for the parties involved in the knowledge transfer process is when they both experience an increase in the level and value of their knowledge stocks. The successfulness to reach such an outcome largely depends on the parties' *knowledge transfer ability*. Husman (2001) argues that this ability consists of an absorptive capacity and a transmissive capacity. The higher the *absorptive* capacity (the better the parties are at understanding the knowledge received), and the higher the *transmissive* capacity (the better the parties are at explaining and codifying knowledge and for transferring it), the smoother the knowledge transfer process. However, the final outcome of this process is influenced by the intensity of the *knowledge transfer costs* causing such high *knowledge transfer abilities* not always to be achieved.

The level of knowledge transfer costs are to a great deal determined by the characteristics of the knowledge being transferred. According to Veugelers & Cassiman (2003), the highly uncertain, *non-codifiable*, and *tacit* nature of scientific knowledge results in high knowledge transfer costs and thus requires the presence of proficient absorptive and transmissive capacity

at each side of the market transfer in order to establish a successful UIR. In this regard, *tacit* knowledge refers to knowledge that is personal, context specific, hard to formalise and communicate, whereas *codified* knowledge is structured in a way that makes it easier to store, reproduce, communicate and trade (Dosi 1988). The characteristics of scientific knowledge give rise to forms of cognitive-related costs: loss of knowledge because of an inability of the parties to understand each other, and incentive-related costs: transaction costs (Williamson 1975, 1985) arise if parties have incentives to act opportunistically (Nooteboom 1999) implying that one party tries to maximise his or her self-interest at the expense of the other party's benefit. Faculties, firms and institutions must thus strive to minimise the costs associated with *understanding* each other (cognitive costs) and to reduce the partner's *incentives* for opportunistic behaviour (incentive related costs).

Subsequently, Husman (2001) provides a taxonomy of determinants of cognitive and incentive related costs. She argues that two ways of minimizing costs has to do with the 'frequency of interaction' and the 'knowledge transfer experience'. The higher the frequency of interaction, the closer the relationship is likely to evolve between the parties and the better the understanding of the knowledge being exchanged, and of the special language and organisational culture experienced, the lower the cognitive costs. In addition, the frequency of interaction is an essential determinant for incentive related costs. Over time increasing frequent interaction could lead parties to experience that the other does not act opportunistically, and that thus protectionist safeguards make place for inter-organisational trust to be developed and thereby reducing the incentive related costs. The knowledge transfer experience particularly affects the cognitive costs and refers to the learning process. The more experience parties have with the particular type of knowledge transferred, i.e. scientific knowledge, and the parties' knowledge transfer experience with each other, the more enhanced and identical their absorptive and transmissive capacities, and the lower the cognitive costs.

On the basis of the knowledge transfer cost theory, our intuition is that experienced faculties that have acquired knowledge in transferring scientific know-how, and in establishing continuous relationships with firms and/or public institutions over time have developed proficient absorptive and transmissive capacities fuelled by learning processes and trust building in order to minimize both cognitive and incentive related costs and are therefore more successful in establishing UIRs. As a result we hypothesize that the contract characteristics of experienced faculties, with a relatively stable base of research contracts, can be typified by longer duration and a higher monetary value. At the other extreme, the relatively inexperienced faculties in UIR-contracting have an insufficient contract research base to develop the necessary skills as pointed out above. We therefore hypothesise that, with the lack of a solid base resulting in a relatively low experience in contracting and lower

absorptive and transmissive capacities, the incidental character of signing contracts of a faculty with firms and other institutions takes the overhand, which results in a contract portfolio with a more fluctuating amount of contracts signed of a shorter duration and lower monetary value.

Hypothesis 1a: Experienced faculties' UIRs can be characterized by longer term contracts than UIRs established by non-experienced faculties.
Hypothesis 1b: Experienced faculties' UIRs can be characterized by contracts with a larger monetary value than UIRs established by non-experienced faculties.

In contrast to our learning hypotheses, we alternatively hypothesize a more demand-led approach to UIRs as the foundation of our second explanatory hypothesis. The changes in the average contract characteristics over time are possibly caused by a structural shift in the demand for research collaboration by industry with universities. In section 4 we showed that for all types of faculties, being faculties heavily involved in contract research and those that involve in contract research to a lower degree, the demand shifted towards contracts with higher budgets and a longer duration at the expensive of the short-term small sized contracts. Whereas the amount of contracts signed remained relatively stable, it is a sign of structural change in contract characteristics and in the relationship between universities and firms and public institutions.

The implications that the two interpretive hypotheses have, are highly informative for policy makers in their pursuit of formulating the best innovation policy. If faculties 1) successfully develop the learning necessary for the management of their contractual relationships, which allows them to specialise in larger and longer-term contracts or 2) if they simply react to changes in demand regardless of their experience in contractual relationships, have different policy implications. If the faculties are already responsive to changes in demand, i.e. demand-led, than policies to enhance responsiveness (incentives) for universities to increase their interactions would already have been realised. Policy aimed at "deepening" the university supply towards long-term contracts with high budgets will most likely be more fruitful.

4.3 Methods and Results

In order to test the two hypotheses we put forward the concept of 'experienced' and 'non-experienced' faculties. These are defined accordingly:

1. An experienced faculty is a faculty that has been continuously involved in UIRs during each single year of the period of discussion, and asserts an above 'average' amount of new signed contracts in every sub-period.

2. A non-experienced faculty is a faculty that has been irregularly involved in UIRs during each single year of the period of discussion, and asserts a below 'average' amount of new signed contracts in every sub-period.

The 'average' is defined as: (total amount of contracts over the 12 year period / 4 sub-periods) / 8 faculties, which results in an average of 68.2 contracts signed per sub-period. Although we acknowledge that calculating averages has a smoothening effect, and thus might result in some bias, we do feel confident that the definition has enough strength to validate the test. In addition to the latter, we have taken account for the fact that there could be a faculty with a disproportional large amount of contracts with a low monetary value, what in turn could bias our results. In this case, total revenue figures throughout the twelve year period of our study also indicate that our faculty classification is justified.

Table 4.2 *Contracts by faculties – 4 sub-period*

	1992-1994	1995-1997	1998-2000	2001-2003
Economic Sciences	5	13	13	19
Spatial Sciences	14	14	2	7
Management & Organisation	14	12	8	10
Law	14	21	17	21
History & Arts	20	37	30	7
Mathematics & Natural Sciences	117	106	90	80
Psychology & Social Sciences	168	124	128	70
Medicine	202	197	242	362

The results in table 4.2 point to a vast appearance of the faculties of Medicine, Mathematics & Natural Sciences, and Psychology & Social Sciences compared to the other sciences. Accordingly, these faculties are defined as the experienced faculties. These are the same faculties that fall under the C3 ratio and provide some additional support for the strength of our definition. However, we do acknowledge that the results in table 4.2 could lead to a potential bias as they are largely consistent with the familiar Alfa/Beta/Gamma classification. The reasons for this bias to occur are twofold: first, there is a roughly 80/20 budget division between the Beta and Alfa/Gamma sciences. As a result, the Beta science faculties have a disproportional larger budget to spend on research and research facilitating activities. Second, the student density in Beta sciences is much lower compared to Alfa/Gamma sciences where professors are forced to devote much more time to teaching and directing students than on doing research. One can easily conclude that the former two facts are to some extent responsible for the large differences in the amount of contracting. Nevertheless, this does not imply it has a direct effect on the value and duration of a single contract.

When interpreting the first learning hypothesis, assuming that it is correct, we should be able to find a difference in contract characteristics of the experienced faculties with the non-experienced faculties. Alternatively when our second, demand-led hypothesis, is true we

should not be able to find any significant variation in the contract characteristics of the two types of faculties. Statistically this means that the demand-led hypothesis assumes both clusters to be identical (*H*o:), and the learning hypothesis implies that not both clusters are identical (*H*a:)

In order to test the hypothesis we used the nonparametric Mann-Whitney-Wilcoxon test for the reason that the form of the probability distribution cannot be estimated and the scale of measurement is nominal. This test allows us to determine whether the two independent populations are identical. We have created a dummy variable for the experienced faculties, which functioned as a grouping variable and tested the significance by using contract value and contract duration as our dependent variables.

The results of the tests seem to provide an unambiguous answer (see appendix 1). There is clear evidence to support the interpretation that non-experienced faculties that engage in third-stream contract research are involved in shorter term and lower budget orientated contracts. More importantly the results confirm the existence of relevant learning processes going on in the experienced faculties. In these faculties contracting activities have become more standardized and structured, encouraging economies of scale of a managerial and organisational character that additionally could facilitate and accelerate future third-stream activities. The most imperative implication for policymakers is that national and internal policies need to be critically reassessed and, in extreme cases, need to be revised and reformed to a policy that takes in to account the specific situation and culture of each faculty more explicitly, resulting in a 'tailor-made' policy that induces an optimum level of learning and third-stream research.

A good example of how a collective innovation-enhancing policy pursued by the government can at times have a detrimental effect on some faculties while invigorating others is the government's imposition of budgetary stringent measures by limiting first-stream funding. This is done with the aim of intensifying university-industry knowledge sharing. In general, these measurements have had the proposed effect. However, when evaluating the performance of faculties the government and the university's board of directors uses primarily visitations and the number of scientific publications as key criteria for success, but has limited attention for the evolvement in third-stream activities. This peculiarity has forced smaller faculties in particular to turn away from third-stream activities as they had to allocate their already scarce resources towards second-stream, NWO funded, research of which they knew it would lead to the desired scientific publication, whereas in contract research it is not the prime objective of the mutual knowledge sharing relationship.

These collective innovation-enhancing policies on the one hand, and the conservative attitude of the university's board of directors and the visitation committee on the other hand, have a sincere detrimental effect on third stream research activities in some faculties. This 'schizophrenic' picture of policy contradiction is highly unproductive and could lead researchers to alienate. In practice a researcher can generate a great deal of third-stream contract revenue while being 'disciplined' by the visitation committee for his low amount of highly cited scientific publications. Moreover, there is hardly any gratitude from fundamental researchers and the university's board of directors as they reason from the same point of view.

In the final section we will discuss a number of explanatory variables and draw the main conclusions that, in our view, contribute to a large extent to the widely differing performance of the university itself and the separate faculties.

5 Concluding remarks

The main outcome of the paper is that the statistical analysis of third-stream contract research shows in an empirical way that organizational learning is possible and that a learning process is present, subsequently it can be argued that each faculty is at a different stage in this learning process. Note, however, that the demand led hypothesis is not abandoned and that these two hypotheses are co-existent in varying compositions. One of the implications this result has for policymakers is that by acknowledging the different stages of learning it should be able to construct policies suitable for these different stages and thereby enabling faculties to reach an optimum level of learning.

In order to unravel the specific factors underlying the university's performance in scientific research and the large disparities in faculties' performance in third-stream activities, we have set up a series of interviews with each faculty's third-stream coordinator. The interviews comprised a number of relevant topics that repeatedly showed up in academic literature (see appendix 2). The specific problems that each faculty faces appear to have some common denominators, which can be clustered in experienced and non-experienced faculties. We will illustrate our arguments with specific results and examples from the interview sessions.

An often heard argument for the underperformance in third-stream research of the University of Groningen that has been put forward in the interview sessions relates to the lower level of regional business development in the north of Holland. However, there are some essential considerations that should be taken in to account: how should the 'region' be defined and what role does the 'region' play when it comes to third-stream research in the Netherlands? We regard other factors to be of a larger explanatory value. One argument has already been touched upon in the paper and points to the 'entrepreneurialism' of a university. A number of Dutch universities are more entrepreneurial and put a strong emphasis on the establishment of UIRs through third-stream research activities, whereas the RUG is clearly a classical university that gives a higher priority to fundamental research and teaching.

A legitimate question that needs to be asked is: how long will the university be able to sustain this classical view when the government continues to drive universities to the entrepreneurial side of the spectrum? The primary reason for universities and faculties to remain conservative in their policies refers to the evaluation mode, where universities and researchers are judged and admired, but not necessarily rewarded, in accordance with the 'classical' performance indicators and not on their entrepreneurial excellence. Not surprisingly, a university's board of directors that clings on to this conservative ideal does neither reward nor stimulate faculties to employ activities in this new arena. It is the authors' opinion that this culture will not

revolutionize unless changes are realised up to the 'ivory tower' of the university's board. A university that wants to explore its entrepreneurialism needs entrepreneurs, managers out of the field, which in the end could lead to a better balanced and effective board of directors willing to incorporate policies involving *all* streams of research.

The government tries to stimulate these entrepreneurial activities by reducing first-stream funds, but the inherent contradistinction that pops-up in the latter is that the government demands universities to perform the same level and quality of classical tasks and to develop extra activities in relation to contract research with lower first-stream funds and high learning and transitional costs for carrying out these activities. In practice, the financial consequences of this policy are especially harsh to the non-experienced faculties. An additional consequence is that universities divert more efforts in generating second-stream funds. In relative terms, this means that each university competes more intensively for a piece of the NWO pie. This implies that by not seeking for external sources of income (contract research) the prospects for a university of a healthy financial situation and a productive research environment are cloudy and uncertain.

In the last decade, the RUG has implemented incentive schemes to enhance academic research, favouring the formation of science parks, the facilitation of academic spin offs, and the implementation of patenting and licensing programmes. However, the effectiveness of the related institutions is under debate, which is supported by the interview results. Illustrative examples in this regard are that none of the faculties could give us a clear picture of the activities of the university's science park, or, in particular could confirm any fruitful research-enhancing relationship. And second, the faculties that are involved in IPR related issues all questioned the added value of the Patenting and Licensing Office. On the other hand, the services provided by the Transfer and Liaison Group (TLG) are regarded as valuable and are employed by many faculties. However, the TLG is not the key-intermediary between the university and the northern business region as they point out. Their supporting activities are predominantly concentrated on the assistance in obtaining European funds for research projects and function as a guide through the administrative 'jungle' connected to these funds. From these examples can be concluded that the institutional actors are not functioning at full potential and, therefore, should be able to perform more supporting activities for each faculty. In accordance with the theory (mode 2, triple helix) the university and faculties should interact more with the 'supporting' institutions in order to streamline and optimise the required services.

Another critical point in contract research and more specifically in the establishment of UIRs that came up during the interviews is the 'administrative barrier', which functions as a hurdle and appears to be a serious disincentive for researchers to engage in third-stream activities.

Particularly in the experienced faculties increased efforts are diverted towards supporting activities that facilitate the administrative process and thereby allow the researcher to focus on his/her core task: doing research. A good example of 'supportive optimisation' can be found at the Faculty of Medicine, where a specific financial output for research projects is developed in dialogue with the researchers, which only includes the relevant fields for the researcher's research progress. This initiative is unique and is not seen in other faculties, whereas the need for such a financial output is general across faculties. The university should be aware that the solution to a problem, like the financial output, is not invented several times and thereby wasting time and money that could have been spent more efficiently. In this regard, an increased frequency of interaction between faculties is essential, potentially efficiency enhancing, and stimulating to the learning process. Especially, since the non-experienced faculties lack the financial capabilities and manpower to develop the necessary skills independently, they are to a higher degree faced with the 'administrative barrier'.

In all faculties there is a conviction about the necessity of generating external sources of income in the future but surprisingly most of the non-experienced faculties have not developed an explicit third-stream policy. A quick look in strategic reports of the respective faculties shows that, in particular, the non-experienced faculties do not provide a clear vision on the policy and goals for third-stream research as a 'new' source of income. The fact that policies and incentive structures are 'work in progress' is illustrated by Oosterhaven (1999) in "The Second Notation Contract Research of the Faculty of Economics", in which several researchers assess, correctly or not, that performing contract research compromises with producing higher valued publications in international (prestigious) journals and with that a possible disincentive arises since the researcher's performance is not evaluated in terms of contract research.

In relation to the incentive structure, the experienced faculties are more encouraging and facilitating towards contract research than the non-experienced faculties. The fact that some non-experienced faculties in the recent past explicitly pursued a policy of reducing third-stream contract research is illustrative. Other non-experienced faculties have deliberately set up a structure in which most contract research activities are performed outside the faculty by an independent entity where strong linkages, based on personal networks, allowing knowledge transfer to take place. The independent structure is a result of the faculty board's belief that a faculty should not compete with private companies. This expresses that the faculty board's attitude towards contract research plays a crucial role in the organizational setting of third-stream research. The importance of contract research is expressed in the augmented interest by faculties in incentive related topics such as: intellectual property rights, performance contracts, wage differentiation, flexible labour force and labour evaluation. Again the experienced faculties take a leading role in this discussion, in this regard a more

proactive role of the faculty boards and the university's board of directors is desirable. A comforting fact that the interviews revealed is that the non-experienced faculties are increasingly aware of their 'third mission', and some have set ambitious policies and goals.

The results from the analyses and the interviews suggest that there is a strong scientific research culture within the RUG where generating high quality scientific publications is regarded as more prestigious than carrying out applied research for businesses and public institutions. Although this culture is present in all faculties, it is more pronounced in non-experienced faculties where third-stream activities are almost entirely dependent on a few dedicated researchers. These non-beta faculties are faced with a larger 'relative distance' between fundamental and applied research, that is, the ease by which first and second-stream activities can be combined with third-stream activities. For the experienced faculties this 'relative distance' is smaller and explains why a large group of researchers is actively involved in all streams of research and more willing to perform third-stream contract research. This entails that scientific research and applied research are not mutually exclusive.

The research culture question, especially in the non-experienced faculties, is a question of balancing the 'old' activities with the 'new'. The need for balancing is eminent, because the traditional tasks that a university has to perform are well defined, whereas important tasks in relation to third-stream activities are still open for discussion and remain undefined. Policy makers should be appealed to find a solution for this problem of definition, as it lies at the core of most issues at hand. When researchers are confronted with these undefined and uncertain issues, they are more likely to take a familiar (scientific) position. A well defined and balanced policy comprising all streams of research creates clarity and provides a good rationale for researchers to perform either form of research. The latter combined with a network type structure and intensified interfaculty communication could improve organisational learning that in the end results in a better research performance of the university as a whole. It would not surprise the authors that the University of Groningen could learn and improve a great deal by just looking at itself.

In this paper we tried to illustrate the importance of an irreversible phenomenon: the establishment university-industry relationships through the progression of third-stream activities, which will be irrevocably part of every university in the 21st century. We hope to encourage other graduate students to take up this phenomenon and conduct similar types of research in the future to empirically address the evolution in contract activities at the University of Groningen. In the end, all third-stream coordinators had a positive attitude towards the future development of third-stream activities. If they commit themselves to put these words into actions, we are convinced that there will be a cultural change within the

deepest parts of the university maybe not necessarily because they want to, but because they have to!

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Appendix 1 Statistical Results

Non Parametric Tests: Mann-Whitney Test

Ranks

	EXPDUM	N	Mean Rank	Sum of Ranks
Contract length	0	295	734,21	216590,50
	1	1886	1146,81	2162880,50
	Total	2181		
Contract value	0	295	876,83	258665,00
	1	1886	1124,50	2120806,00
	Total	2181		

Test Statistics[a]

	Contract length	Contract value
Mann-Whitney U	172930.5	215005,000
Wilcoxon W	216590.5	258665,000
Z	-10,476	-6,282
Asymp. Sig. (2-tailed)	,000	,000

a. Grouping Variable: EXPDUM

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EXPLE	1886	.00	120.00	21.4541	16.0606
NONEXPLE	295	1.00	64.00	12.8932	12.5509
Valid N (listwise)	295				

EXPLE = Experienced faculties contract length

NONEXPLE = Non-experienced faculties contract length

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EXPVA	1886	0	1728540	97048.82	141812.73
NONEXPVA	295	1134	1007347	54863.81	92732.39
Valid N (listwise)	295				

EXPVA = Experienced faculties contract value

NONEXPVA = Non-experienced faculties contract value

Appendix 2 Interview Derde Geldstroom

Het doel van dit interview is om na te gaan hoe elke afzonderlijke faculteit aan de RUG zijn derde geldstroom activiteiten heeft gestructureerd en uitvoert. Mijn interesse in dit onderwerp is ontstaan door het feit dat het overheidsbeleid veelal gericht is op het terugdringen van de eerste en tweede geldstroom alsook de belangrijker wordende maatschappelijke rol die universiteiten dienen te vervullen waar de laatste tijd veel over gesproken wordt. Veelal wordt de derde geldstroom hier gezien als 'de oplossing'.

Voor iedere faculteit heb ik reeds de harde cijfers met betrekking tot de derde geldstroom geanalyseerd, echter ben ik erg benieuwd naar hoe die harde cijfers tot stand zijn gekomen en wat de achterliggende processen zijn. De rol van de mensen, regelgeving en instituties acht ik in deze als zeer belangrijk.

Om het interview soepel te laten verlopen heb ik een aantal discussieonderwerpen geselecteerd, die ik met een aantal steekwoorden hoop te verduidelijken. Alle onderwerpen hebben uitsluitend betrekking op de derde geldstroom.

1. Beleid -intellectuele eigendomsrechten
   -stimulering van onderzoek(incentives)
   -procedures, aanvraag tot tekenen contract
   -contactlegging met externen

2. Instituties -rol TLG, P&L, Science Park, BDG/AC
   -regelgeving overheid
   -(bureaucratische) knelpunten
   -monitoren van onderzoek

3. Cultuur -onderzoekscultuur/attitude
   -opinie DGS vanuit faculteit gezien(belang)
   -maatschappelijk belang 1/2/3^{e} geldstroom

4. Hier en nu -DGS ontwikkelingen laatste jaren
   -toekomstvisie/beleid
   -praktijk

Het is geenszins de bedoeling dat het interview verwordt tot een aaneenschakeling van details, ik hoop echter een goede globale indruk te krijgen van de DGS activiteiten binnen de faculteit.
Mocht er binnen de faculteit enige documentatie aanwezig zijn die betrekking hebben op een van de bovengenoemde gespreksonderwerpen, dan zou ik u zeer erkentelijk zijn.
Alle informatie die verstrekt wordt tijdens het interview is mijns inziens vertrouwelijk en wordt daarom als zodanig behandeld.

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